India and the Atom

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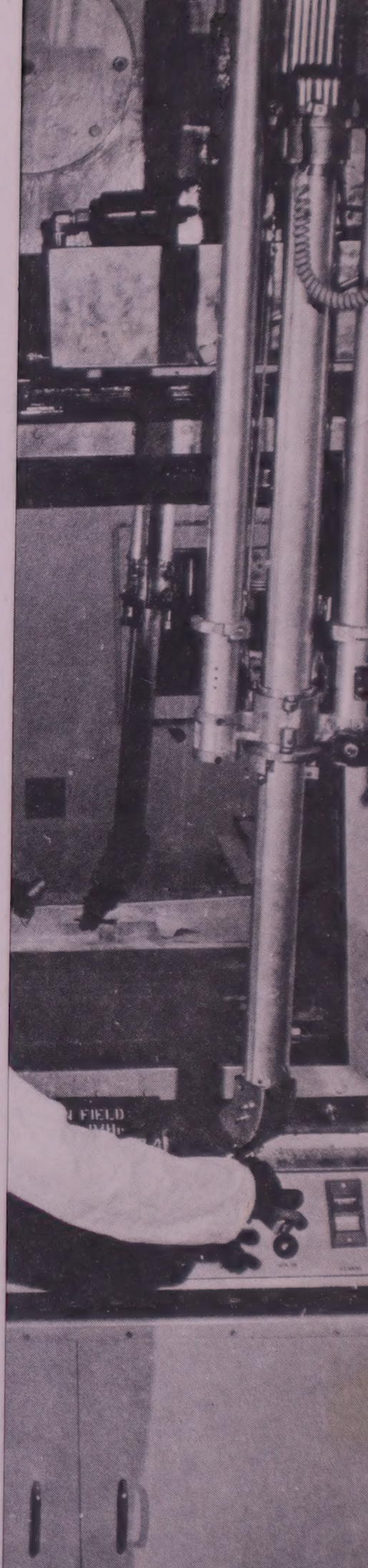
Indian science is dedicated to peace, its motive is development. All the major achievements of Indian science so far have occured in its search for peaceful uses and not as a spin-off of defence rquirements. This is true of Pokharan and Sriharikota.

Smt. Indira Gandhi



DAVP SCIENCE AND TECHNOLOGY SERIES

Introduction

It can rightly be said that within a brief span of one decade, India has broken the shackles of gravity and soared into the space age.

India has also emerged in less than three decades as a world leader in the peaceful uses of atomic energy.

The youth of India should have at least a nodding acquaintance with the pioneering work which those slightly older than themselves have done to raise the country to this pinnacle of pride.

Besides, there is a growing demand for trained scientific and technical personnel to carry forward the research and development (R & D) work in these and other fields of science and technology. Our high schools, colleges and universities are the obvious catchment area for this talent. There are bright and satisfying careers awaiting students of science and technology.

To them and their future this series is dedicated. DAVP acknowledges with gratitude the contribution of the various Departments and Institutions on whose work and data the publications in this series are based.

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G.S.P. SURI,
General Editor

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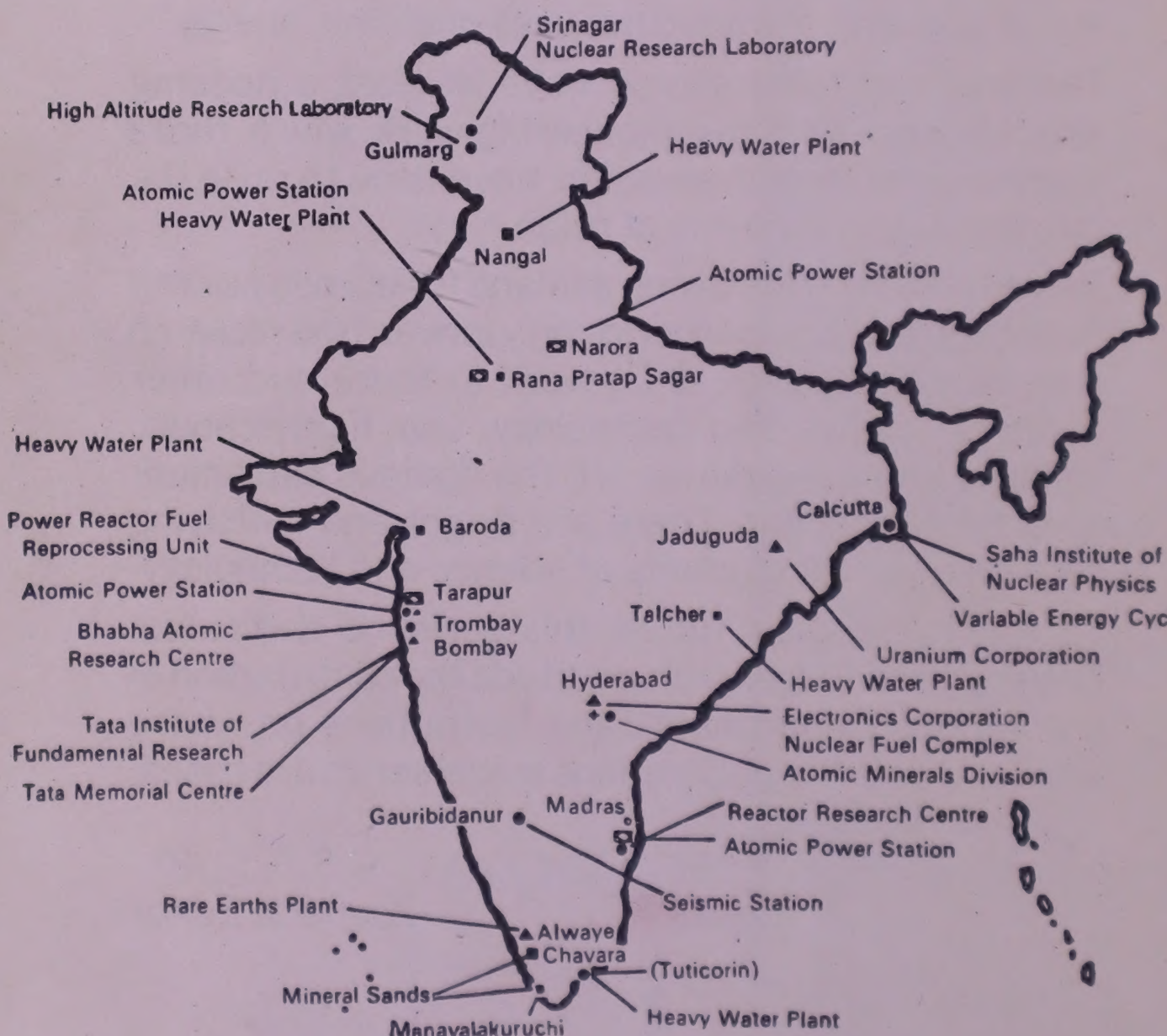
ATOMIC ENERGY ESTABLISHMENTS



and the atom

India is gradually attaining self-reliance in all spheres of nuclear science and engineering.

Though the country has had a rich and varied tradition of fundamental research, organised studies in nuclear sciences began only in 1945 with the establishment of the Tata Institute of Fundamental Research in Bombay.

At the end of the Second World War, when most nations viewed atomic energy as a force of destruction, India was already thinking in terms of using it solely for economic development.

Thus, India started work in the peaceful utilisation of nuclear energy at a time when it was essentially very much of a frontier science, into which a few developed countries alone had ventured.

WE HAVE COME A LONG WAY

India has reached a stage where it has a sound infrastructure of industry and know-how to support and sustain all the activities in the nuclear field.

India is amongst a handful of countries in the world and the only developing country, to operate the complete fuel cycle-right from uranium exploration and mining

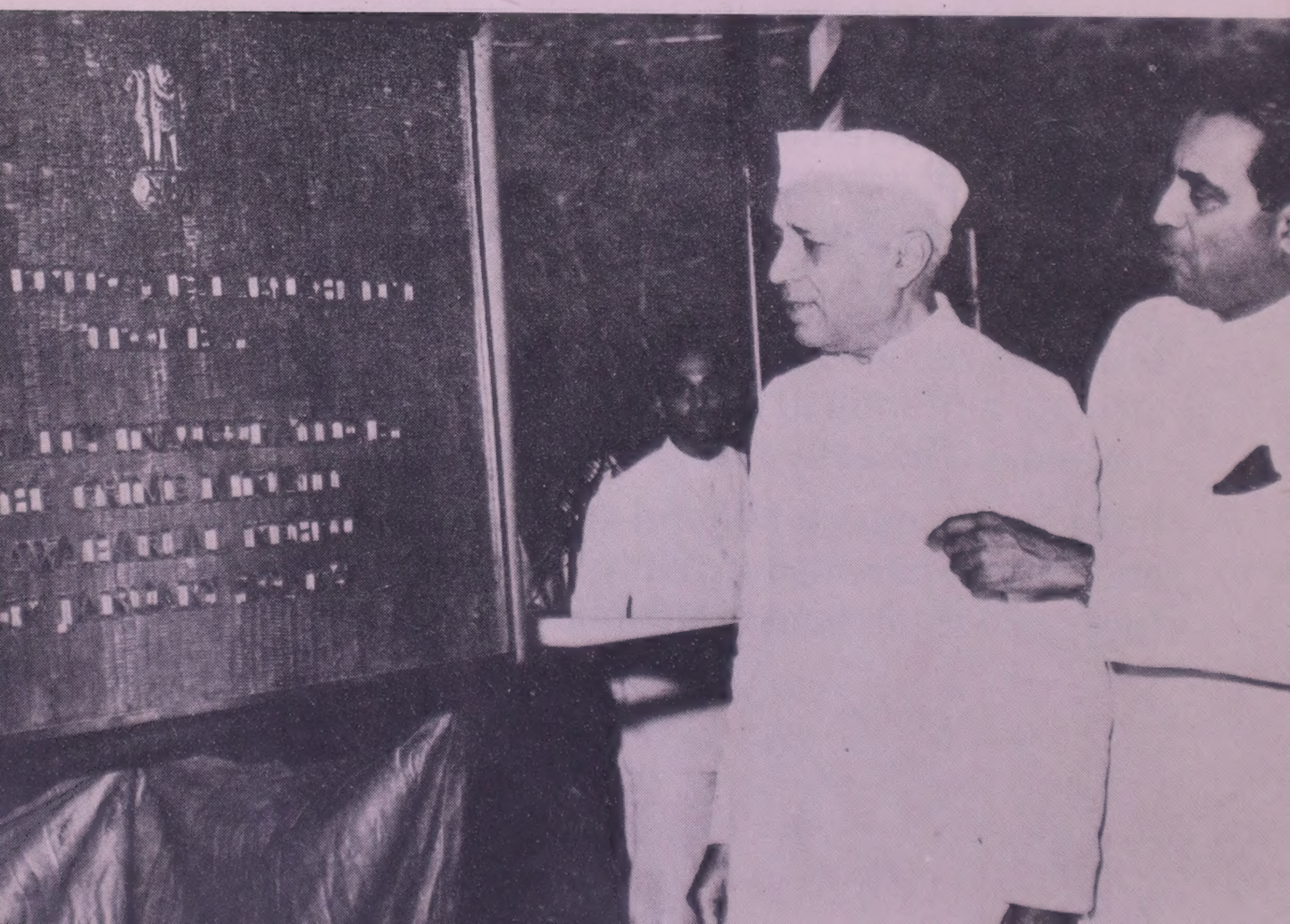
to its conversion to nuclear fuel, its reprocessing and the final management of waste.

In attaining this degree of self-reliance, India has earned for itself a place amongst the countries most advanced in the technology of atomic energy.

MANY USES

The prime objectives of India's atomic programme were defined in the Atomic Energy Act of 1948: development, control and use of atomic energy solely for peaceful purposes, namely, the generation of electricity and the development of nuclear applications in research, agriculture, industry, medicine and other areas.

Inauguration of the Atomic Energy establishment at Trombay on 20th January, 1957.



The Atomic Energy Commision, set up in August 1948, is responsible for all these activities in the country. The executive agency for implementing the programmes is the Department of Atomic Energy which was set up in August 1954.

To achieve the objectives mentioned above, efforts were initiated to build up a versatile infrastructure of research facilities, trained scientific and technical manpower, raw material processing centres and the know-how and capability to manufacture nuclear components and electronic equipment to support the atomic energy programme.

Today, there are 4 research reactors in operation with a fifth one under construction at the Bhabha Atomic Research Centre, Trombay. There are also 3 power reactors in operation, one getting readied for operation, and 4 under construction.

RESEARCH REACTORS

In 1954, it was decided to build a 1 MW swimming pool reactor (APSARA). Although such reactors were readily available on sale from some developed countries, it was considered that valuable experience would be gained if Indian scientists and engineers were to undertake the task.

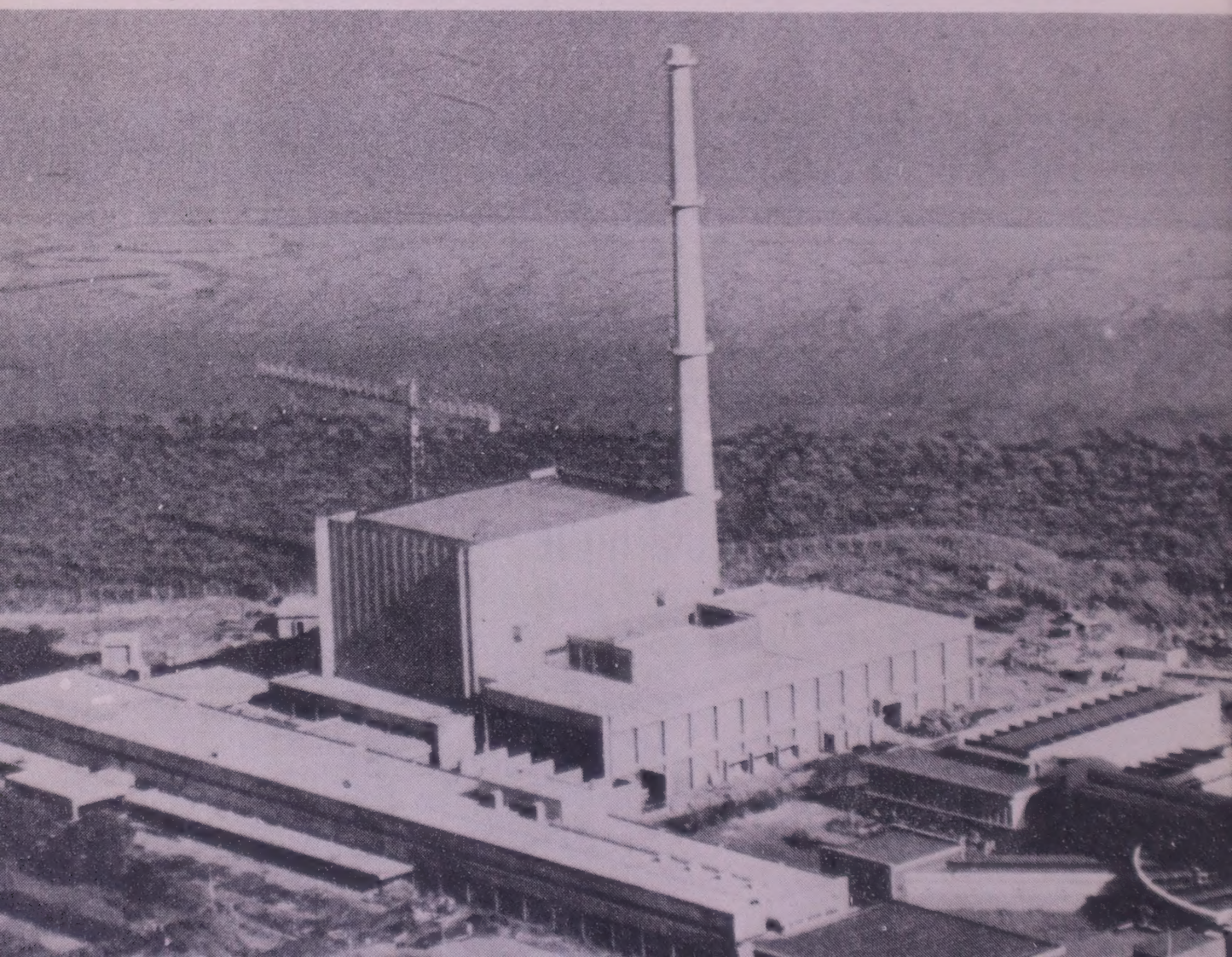
The reactor started working from September, 1956. Under the conditions prevailing then, this was recognised as a remarkable achievement, as even among countries then considered advanced in the nuclear

field, only a handful had built their own reactors. APSARA was at that time the only reactor in Asia outside the USSR.

CANADIAN COLLABORATION

About the same time that a decision was taken to build APSARA, attention was given to a high flux reactor for engineering experiments, materials testing and isotope production. In 1956 it was decided to build CIRUS, a 40 MW natural uranium, heavy water moderated reactor, with Canadian collaboration.

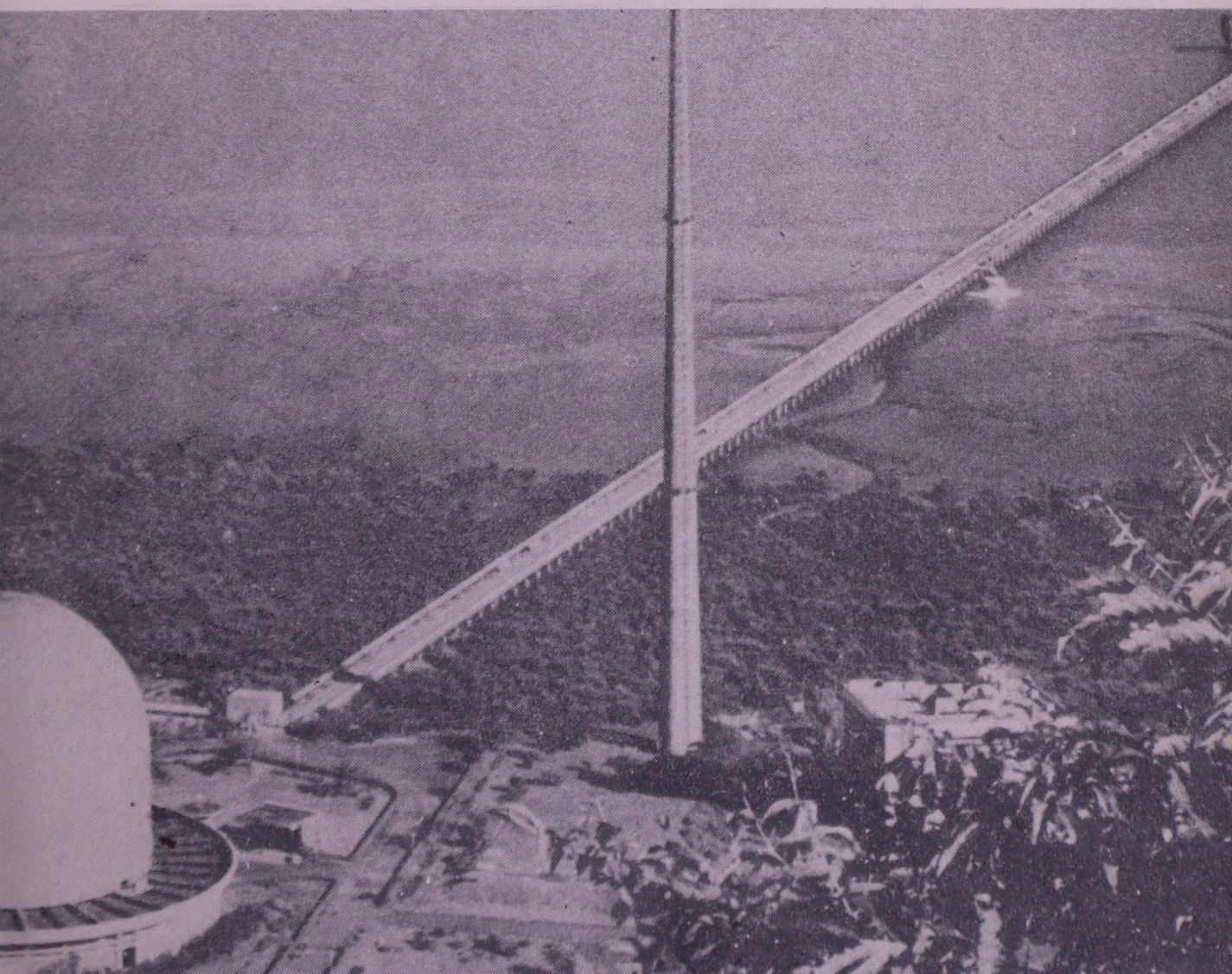
A view of Cirus and R-5 reactors at Trombay



An important achievement was the entirely indigenous fabrication of half of the initial fuel charge in a fuel fabrication plant that had been set up with indigenous R & D and know-how. The reactor became critical in mid-1960 and continues to operate, providing valuable production, research and training facilities.

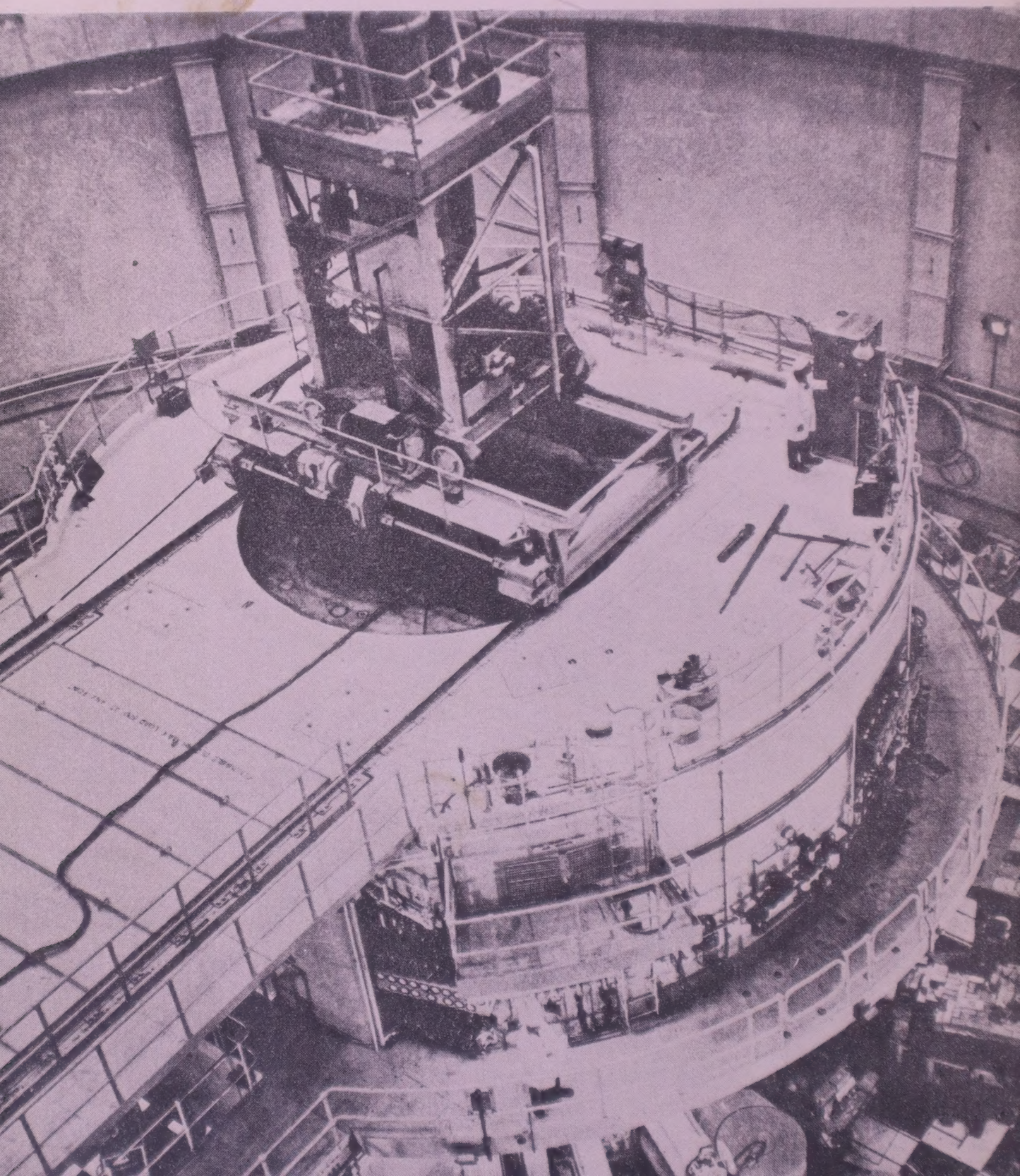
ZERLINA AND PURNIMA

In early 1961, a zero energy reactor, ZERLINA, was commissioned. This reactor was designed and built by Indian scientists and engineers. It uses natural uranium as fuel and heavy water as moderator.



The reactor is used for studying new reactor concepts and components. As the core design can be varied, it has a very complicated control system with many

An interior of the Cirus reactor



automatic checks and safety devices.

In mid-1972, PURNIMA, as experimental zero energy fast reactor, was put up for studies in fast reactor physics. The plutonium oxide fuel elements for this reactor were fabricated at Trombay.

As the CIRUS reactor is now 20 years old, it was decided to put up a new high flux reactor (R-5) at Trombay. This is a natural uranium heavy water moderated reactor of 100 MW for production of isotopes for special applications, and also for development of power reactor technology.

R-5 has been designed and is being built entirely by Indian scientists and engineers. It incorporates many new features, including a new fuel concept.

ELECTRICITY FROM THE ATOM

The major thrust of India's atomic programme is towards generation of electrical power.

For putting up India's first atomic power station, Tarapur near Bombay was chosen in 1958 after a comprehensive survey of a number of possible sites all over the country.

Indian engineers could have undertaken the design and construction of this station without any foreign collaboration, but this would have taken a much longer time. To bring nuclear power to the country without delay and to give an opportunity to Indian technical personnel to acquire experience in building and operating a nuclear power station, a tried out system was bought to begin with.

Two Boiling Water Reactors (BWR) of 200 MWe each were purchased from the USA, in 1964. The Tarapur Station was built as a turnkey project by the USA, but with maximum participation of Indian personnel in all stages of design, construction, testing and training. Practically all the nuclear/conventional equipment and the fuel elements for this station came from the USA and the station went into commercial operation in late 1969.

The enriched uranium fuel elements for the station are being fabricated in India, from imported uranium hexafluoride. As the Tarapur reactors are amongst the earliest BWRs, several modifications have been carried out to improve the overall performance of the station.

KOTA POWER STATION

The second atomic power station is located near Kota in Rajasthan. It has two 220 MWe reactors of a Canadian design. The first unit of the Rajasthan station has been in commercial operation since and 1973. The second unit is in an advanced stage of commissioning.

Canada was responsible for the design and supply of major equipment for the first unit, while India took up the responsibility for construction and installation activities. Right from the start of this project, efforts were made to manufacture as many components as possible in India. While major equipment, both nuclear and conventional, for the first unit had necessarily to

be imported, part manufacture of some of the major components was undertaken in India. Many items of auxiliary equipment were supplied from Indian sources and half the initial fuel charge was also manufactured in India; in addition, the instrumentation and control systems were, to a large extent, assembled in India.

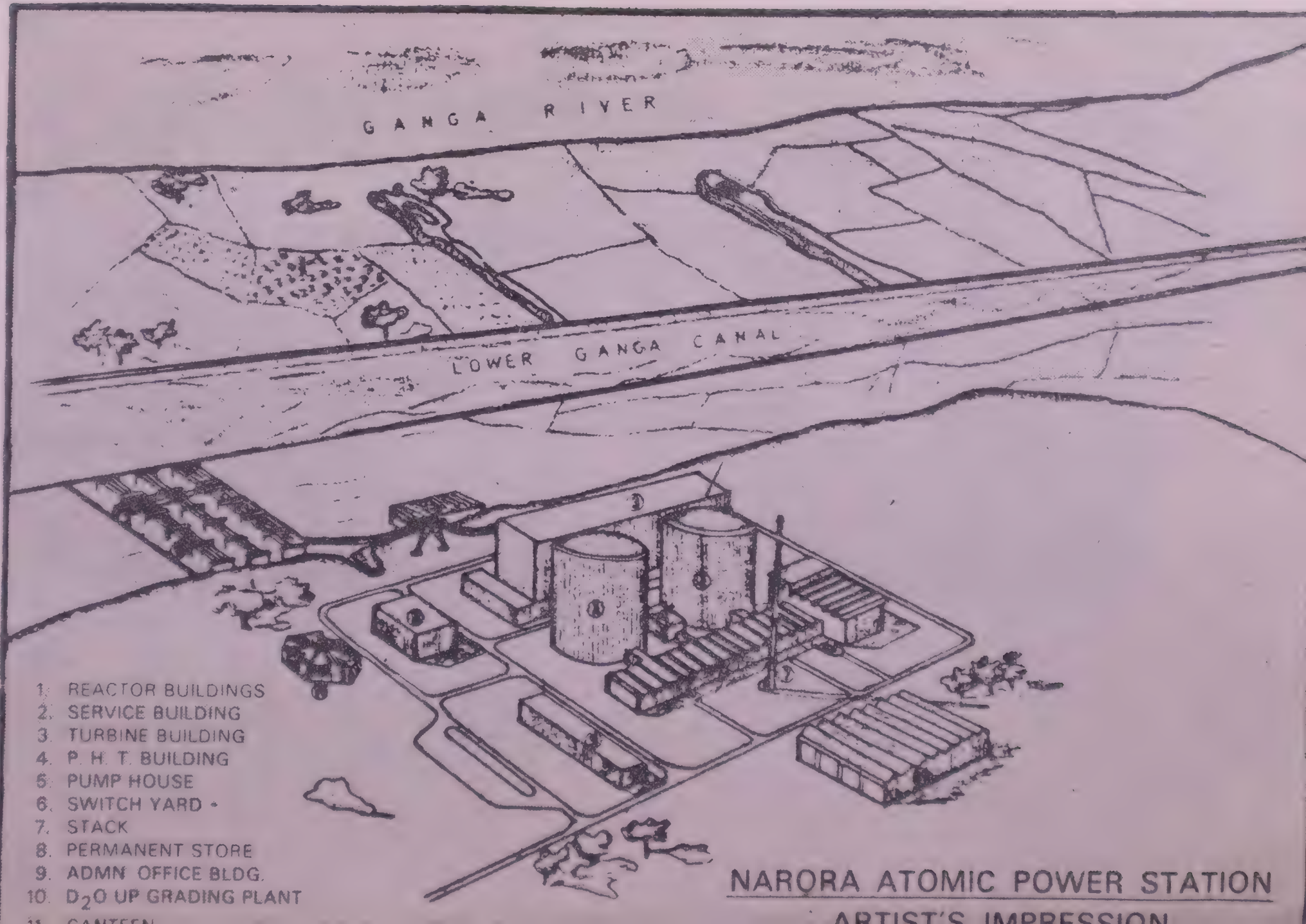
Efforts at indigenization of components were intensified for the second unit and major nuclear components were manufactured in India. Thus, the Rajasthan station opened up opportunities for many Indian industries to enter the nuclear power field and develop sophisticated technologies indigenously.

KALPAKKAM

The third atomic power station is being set up at Kalpakkam near Madras in Southern India.

Two natural-uranium fuelled heavy water moderated reactor units of 235 MWe each at this station are in an advanced stage of construction. Though these reactors are similar to the Rajasthan Units, several design modifications have been introduced for reasons of economy and due to special conditions at the site. Some of the modified features include pre-stressed concrete reactor containment building, stainless steel end-shields, submarine tunnel for drawing cooling water from the sea and an indoor switchyard.

The Madras station marks the coming of age of the Indian atomic energy programme, as full responsibility



NARORA ATOMIC POWER STATION

ARTIST'S IMPRESSION

for the execution of the project, including design, construction, commissioning and operation, rests with Indian engineers and scientists.

NARORA

The fourth atomic power station is located at Narora, in Uttar Pradesh. It will also have two natural uranium fuelled, heavy water moderated reactors, each of 235 MWe.

The Narora Station will incorporate several new design features. As the site is in an earthquake zone, the structure has been designed to make it earthquake proof.

FUTURE PLANS

It is proposed to repeat the design at one or two more sites. A decision to embark on additional power stations at these new sites is expected to be taken in due course.

The future power programme includes 500 MWe heavy water reactors for which preliminary design work has already been initiated. These reactors will incorporate many original features as also utilise some of the features being tried out in the Narora station.

OTHER APPLICATIONS OF NUCLEAR SCIENCE

The Bhabha Atomic Research Centre at Trombay provides the R&D backing to support the nuclear power programme. In addition, it also carries out research in a wide ranging and diverse set of scientific

disciplines and tasks, including the development and application of radioisotopes and isotope techniques in medicine, agriculture, industry and many other areas.

Over 350 radioactive products are prepared at the BARC and are supplied to some 500 institutions in India and abroad.

Radioisotopes are finding use within the country in varied applications ranging from industrial radiography to the diagnosis and treatment of diseases. Important applications of radiations being tried out are in disinfecting foodgrains, developing high-yielding, disease-resistant mutants of, among others, rice, wheat, groundnut and jute, preserving perishable foodstuffs and sterilising medical products.

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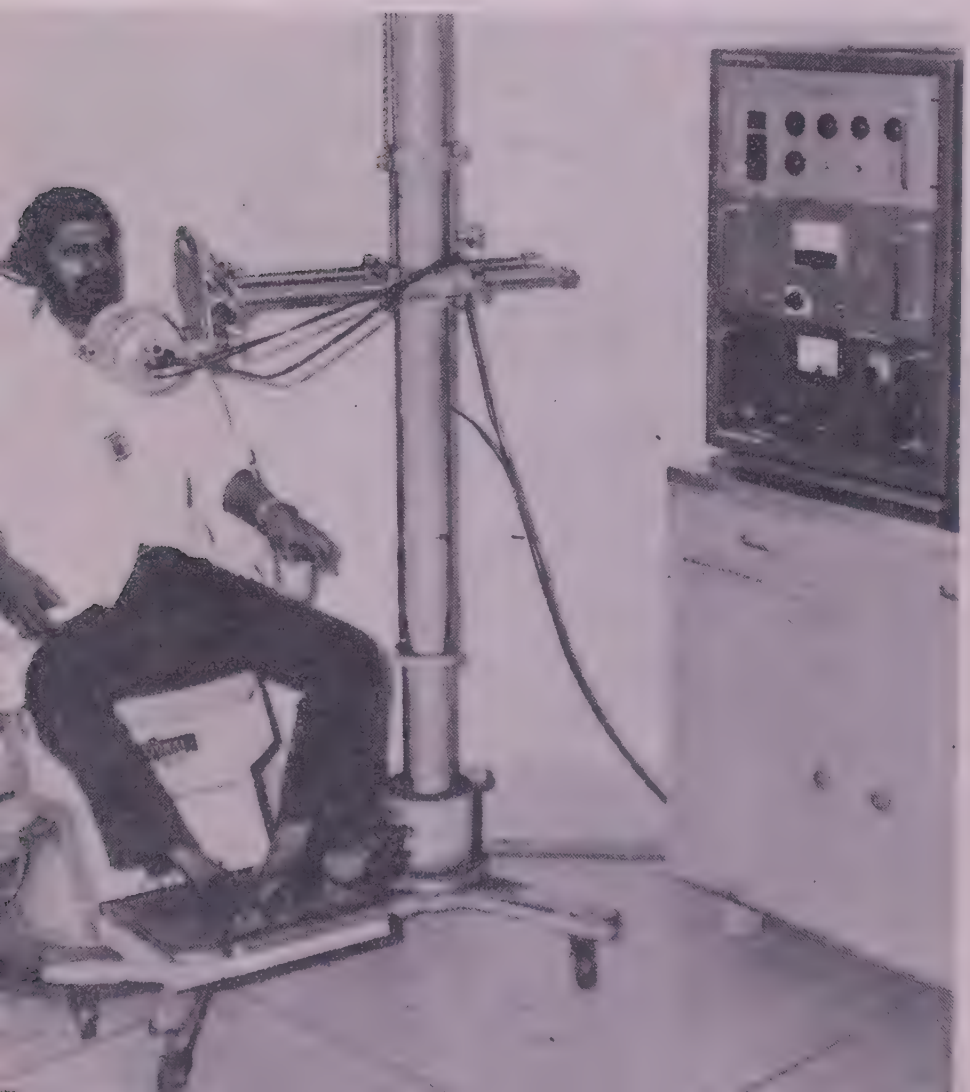

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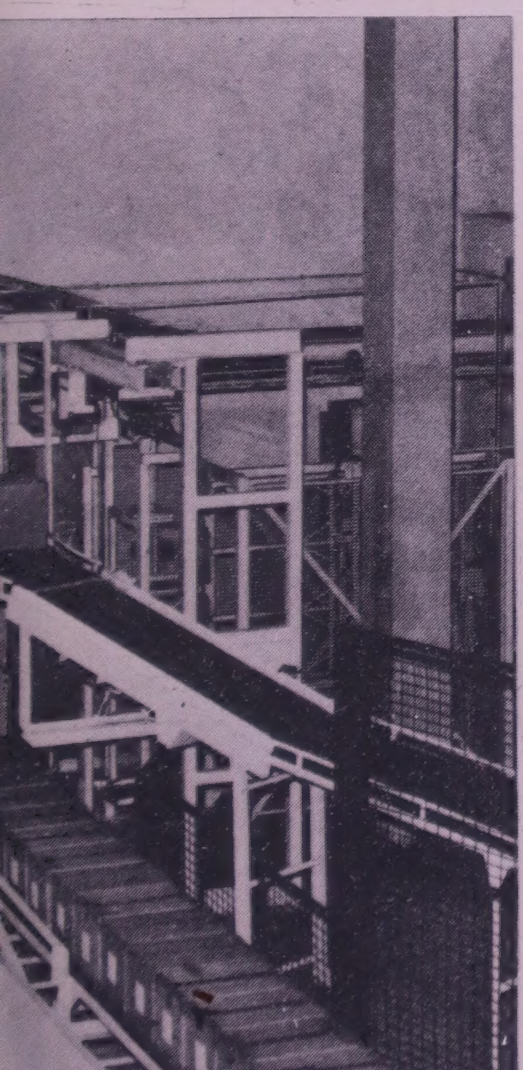
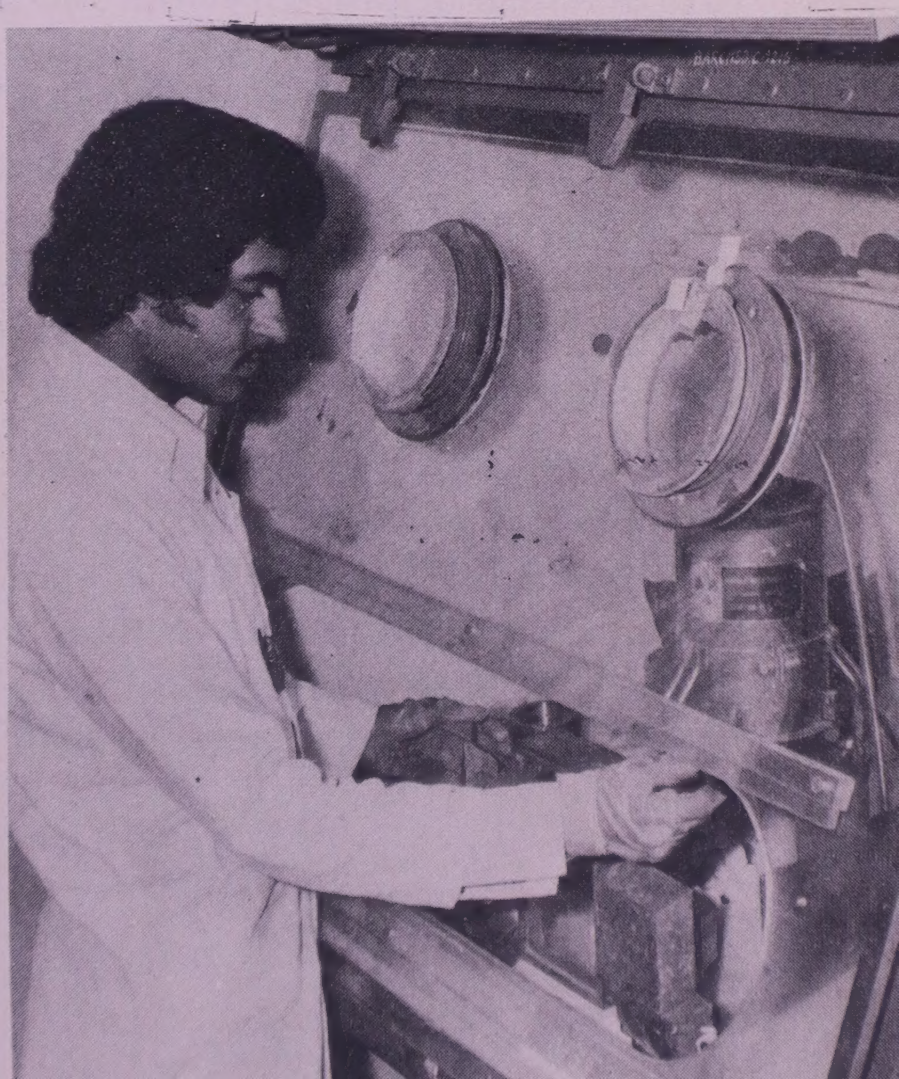
Some of the radioactive products and associated equipment produced at the BARC are also being exported. A commercial radiation sterilisation plant at Trombay, called ISOMED, provides sterilisation service to the medical products industry in the country. The Radiation Medicine Centre at Bombay handles diagnostic and therapeutic applications of radioisotopes.

The Variable Energy Cyclotron, built at Calcutta by BARC, is a national facility for advanced work in nuclear physics, and for controlled direct irradiation of biological and agricultural products.

A Thyroid uptake measurement
B Inside view of ISOMED at Trombay
C Preparation of short half-life radio pharmaceuticals for organ imaging

C





The Gauribidanur Seismic Station of BARC, near Bangalore, helps in the detection and identification of underground nuclear explosions and also facilitates seismic research.

A High Altitude Research Laboratory of BARC at Srinagar provides facilities for high altitude research to all scientific institutions and universities in the country. There is also a Nuclear Research Centre at Srinagar.

SUPPORTING ACTIVITIES

In addition to R&D, the Atomic Energy Programme covers a wide range of independent activities undertaken by units under the Department of Atomic Energy situated in different parts of the country.

Survey, prospecting and development work relating to uranium, thorium, beryllium and columbium-tantalum is carried out by the Atomic Minerals Division with its headquarters at Hyderabad. The Indian Rare Earths Ltd., extracts rare earth minerals and thorium from the beach sands of South India. The Uranium Corporation of India mines and concentrates uranium at Jaduguda in Bihar. A Nuclear Fuel Complex at Hyderabad fabricates fuel elements for nuclear power reactors.

The power reactors being constructed at present use heavy water as moderator. To produce this rare commodity within the country, a small heavy water plant has been functioning at Nangal sicne 1962. Besides this, three heavy water plants are ready at Vadodara, Talcher and Tuticorin and one is under construction at Kota.

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Work on advanced reactor
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NOTABLE ACHIEVEM

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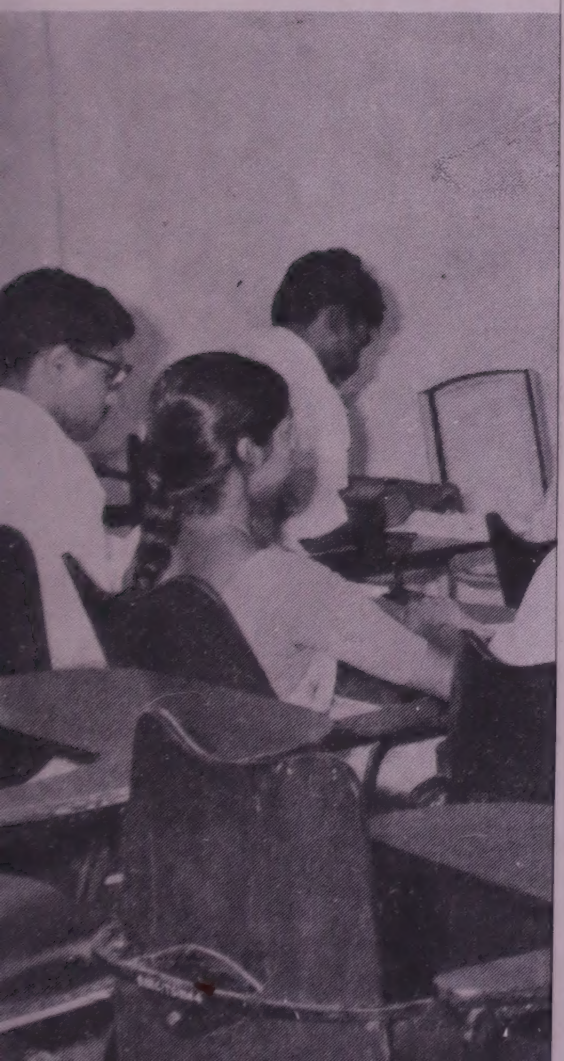

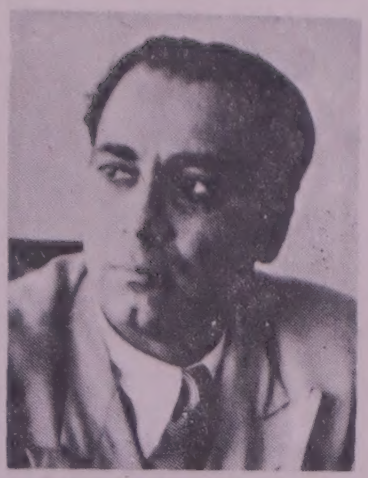

"...for the full industrialisation of the underdeveloped countries, for the continuation of a civilisation and its further development, atomic energy is not merely an aid, it is an absolute necessity"

Dr. Homi Jehangir Bhabha
(1909-1966)

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Bhabha Atomic Research Centre, Trombay

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